Chiral polaron formation on the edge of topological quantum matter

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Immersing a mobile impurity in a quantum many-body environment can reveal fundamental properties of the background medium, hence providing a powerful probe of quantum matter. This approach is particularly intriguing when considering media with exotic properties, such as strongly-correlated phases and topological states of matter. In this work, we study the dressing of a mobile impurity interacting with a chiral mode, as provided by the edge of topological quantum matter. The resulting ”chiral polaron” is characterized by an asymmetric spectral function, which reflects the chirality and group velocity of the topological edge mode and the drag experienced by the mobile impurity. We first build our theoretical understanding from an effective one-dimensional chiral model, which captures the hallmark signatures of the chiral polaron. We then demonstrate how this simple picture extends to realistic models of integer and fractional Chern insulator states, by adapting tensor-network methods to polaron spectroscopy. Injecting mobile impurities on the edge of topological quantum matter is shown to be a powerful tool to probe exotic edge properties, particularly suitable for cold-atom experiments.

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